Explanatory Document

An **Eco-Community Design** for Mount Roskill.

An architectural project based on transforming Mount Roskill to become more affordable, liveable, resilient and sustainable.

Zeelesh Dakshay Kumar
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**COLOPHON**

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Abstract

This project has been done in conjunction with the Auckland Council's proposal on Auckland's Future Plans of increasing its population and to make Auckland "the world's most liveable city". The goal of a liveable city is to express our shared desire to create a city where people can enjoy a high quality of life and at the same time to improve standards of living.

Currently Auckland employs a linear urban metabolism flow of resources, energy and wastes. From the research carried out during this research, this flow of resources, energy and waste isn't a type of system that would be able to sustain itself over the time. This made me wonder about how a typical Auckland suburb could be redesigned and intensified using the circular urban metabolism principles to enhance liveability, sustainability, resilience and affordability.

This project focuses on using Ken Yeang's theory on Eco-Cells and redesigning it so that the principles suits Auckland's culture and also the climate. These principles would be employed in Mount Roskill to test the where the eco-cell principles help to intensify the community and help Auckland to become "the world's most liveable city."

This test would be carried out in two scales; the first being the master-plan which shows how the principles of eco-cells works in the community level and the other scale to design a building which would show how the principle works in a building level.

For the eco-cell, the following goals would be achieved. They are to:

- Create an integrated and vibrant community;
- Create a walkable neighbourhood with diversity of jobs, recreational activities and also residential types;
- Lead the neighbourhood towards carbon neutrality; and
- Improve quality of life and create desirable lifestyle.

Acknowledgement

I would firstly like to acknowledge my main thesis advisor Dr Dushko Bogunovich and also my secondary advisor Cesar Wagner. During the whole year their doors was always open whenever I ran into a problem or even had questions regarding my research. They consistently allowed this paper to be my own work, but steered me to the right direction whenever I would go off track.

I would secondly like to acknowledge all my mates, who have helped me all year round providing me with their support and also with information to look at when I used to get stuck on the problem.

Finally, I would like to express my very profound gratitude to my parents and also my sister for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Thank you.
Autonomous Building - is a building that has been designed to be off the grid.
Biocapacity - this is the ability of biologically productive land to produce biological materials used by people and to absorb the waste materials produced by people.
Blue Infrastructure - this is the integration of circular urban metabolism to manage the water cycle.
Circular Urban Metabolism - this is a process whereby every output from a neighbourhood becomes either input for another process or is returned to the ecosystem harmlessly.
Carbon Footprint - this is the amount of carbon dioxide produced either directly or indirectly to support human activities.
Cropland - this is an area which has been used to produce food and fibre for human consumption.
Eco-cell - is a green integrative device that can be used to make a building or community sustainable.
Eco-city - this is a model of a city that has been a self-sustaining resilient structure and also functions as a natural ecosystems with living organisms.
Eco-neighbourhood - this is a where a district within a city that works to be self-sustainable.
Ecological Footprint - this is the amount of land required to sustain the natural resources which have been impacted by the community.
Economic Performance - this is the success an organization has in terms of assets and liabilities.
Green Infrastructure - this is the interconnected network of the natural areas and other space within the natural ecosystem.
Green Urbanism - this is a conceptual model of an urban design which employs zero-emission, and zero-waste principles.
Greenfield Site - this is undeveloped land within the city that has been considered for urban development.
Global Biogeochemical Process - this is a process that indicates the pathway of the chemicals through the biosphere and the atmosphere.
Global Hectare - this is a unit of measure for an ecological footprint of a building.
Heterotrophic Ecosystem - this is an ecosystem which does not produce sufficient energy to support its needs.
Linear Urban Metabolism - this is a flow of resources where the inputs leads to the output of resources that are waste inclusive.
Metropolitan Area - this is a region where the core is densely populated but the surrounding is less-populated territories.
Urban Metabolism - this is a model that is used to describe the flow of energy and materials within a city.
Urban Socio-economic Activities - these are activities related to the interaction of social and economic factors.
Vertical Composting Unit - this is an aerobic composting system that processes biological waste in a small to medium-sized area.
1.0 Introduction

1.1 Background

In order to understand the expected growth of Auckland’s population by 2040, and also the patterns of that growth, we first need to understand how the world’s population is going to grow in the coming years. Everyone widely knows that no matter what, the world’s population will continue to grow. The United Nations forecast is that the world’s population will increase from two billion in 1960 to nine billion by 2050. This increase in population also means that the majority of people will have to live in an urban area due to the lack of job opportunities in the suburbs and rural areas. This shift in living style will create problems in the environment, which we have already started to encounter, such as weather changes, a rise in sea level, an increase in carbon dioxide in the atmosphere which affects the environment in terms of the ecological footprint. According to Global Footprint Network, our current ecological footprint has been considered to be on the unsustainable spectrum.

1.2 Project Outline

This project is based on the development of an Eco-cell framework that would be suitable for Auckland’s culture. This framework would consist of most of the qualities that a typical Auckland sub-urban area consists of. These are:

- A limited number of job opportunities available;
- A poor connection to reliable public transportation;
- A limited number of job opportunities available;
- A poor connection to a reliable public transportation;
- A poor connection to a green space;
- A poor connection to a green space;
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However, keeping this prediction in mind, and the knowledge that the world’s population will continue to grow, we need to start analyzing our current lifestyle and change our lifestyles to more sustainable ones. This would be beneficial to the environment as it would decrease the ecological footprint.

3.1 The Auckland Region

1.6 planets.

This means that, looking at all the resources we consume in a year, Earth is only able to regenerate three fifths of the resources used. If this consumption rate continues, the UN predicts that by 2030 we would need the equivalent of two Earths to support us.

Keeping this prediction in mind, and the knowledge that the world’s population will continue to grow, we need to start analyzing our current lifestyle and change our lifestyles to more sustainable ones. This would be beneficial to the environment as it would decrease the ecological footprint.

Currently New Zealand has a population of 4.6 million people and has an ecological footprint of 5.6 global hectares per person.

1.3 Aims and Objective

The principal aim of this project is to develop a Framework of Eco-cells specific to the Auckland conditions which later could later be replicated all around Auckland to help achieve its vision of being “the world’s most liveable city.”

This research project is intended to provide an alternative approach on how to deal with the increase in the populations without losing its main culture and identity. The key objectives of this Eco-cell are:

- To create an integrated and vibrant community;
- To create a walkable neighbourhood with a diversity of jobs, recreational activities, and also residential facilities;
- To lead the suburb towards carbon neutrality;
- To improve the quality of life and create desirable lifestyles.

Figure 1. Showing the current Ecological Footprint of Earth.
1.4 Research Question
How can a typical Auckland suburb be redesigned and intensified using the circular urban metabolism principles to enhance liveability, sustainability, resilience and affordability?

1.5 Scope and Limitations
This document is about analyzing the framework that was originally designed by Ken Yeang, and redesigning it to suit the Auckland’s culture, thus helping the neighborhood to become more sustainable, liveable, resilient and affordable. This project focuses primarily on the development of the framework and how it can achieve a better quality of living compared to the traditional suburb.

1.6 Methodology
This research project is comprised of five important components integrated within each other. They are: the context, a literature review, critical analyses of precedents, the design process and a test area site analysis resulting in an architectural outcome.

Chapter 2 - The Context
This chapter takes a step back into history and looks at how Auckland has developed and grown over the past 50 years. It also looks at some of the major events that took place and their impact on the region. It also looks at the two major strategies that were used by the government to help the city to grow. Those strategies were the Smart Growth and Urban Sprawl, which helped the city to increase in density and allowed it to benefit from the advantages this brought about. However, the increase in density introduces the crucial element of the resources the city requires. Hence this section also focuses on investigating on where Auckland gets those resources from and whether they are sustainable or not.

Chapter 3 - Literature Survey
This chapter is a study that has been carried out to first understand what urban sustainability is and also to determine what are the elements and methods that help to make an urban area sustainable. Later in this chapter, the research narrows and looks at an eco-neighbourhood and how a neighbourhood can be consisted an eco-neighbourhood. It focuses on the principles of an eco-neighbourhood and then breaks it down to the theory that Ken Yeang introduced about eco-cells. This chapter gives a brief introduction on the theory of eco-cell and also the features that define it.

Chapter 4 - Precedents Study
This chapter focuses on critically analyzing the precedents that have been considered sustainable in the Auckland region by using the eco-design tool that helps to determine an area’s sustainability. This tool is also used on to make a comparison with the international precedents by comparing and determining the strengths and weakness of each design.

Chapter 5 - Design Process
In this chapter, all the research is been used to create a brief of the eco-cell that would be suitable for the New Zealand culture. It also helps to determine the program and also the elements which would be define the eco-cell.

Chapter 6 - Test Area Site Analysis
This chapter looks at the features in the test site that would help to make the eco-cells different from each other. Some of the features include the current topography of the site, the current hierarchy of the streets, the current green infrastructure, the current building typology, and any specials elements that give the neighborhood its own identity. The research also looks at how the principles of the eco-cell need to be changed to suit the conditions of the site.
The changes in urban life have had a negative impact on the environment globally. According to the United Nations DESA, around 54 percent of the world's populations lives in urban areas. This is expected to increase to 66 percent by 2050. In New Zealand roughly 87 percent of the populations lives in an urban area and about one third lives in the Auckland region. This helps the Auckland region to be rich in cultural diversity and creates a strong economic performance for the region. The Auckland Council has strategies that will be used to help increase the population. Generally, when a city grows it drives a demand for housing on Auckland's distinctive urban form. The large private car ownership, low-density suburbs and a large dispersed urban area. With the increase in demand for housing, Auckland Council has published a plan called "The Auckland's Future Plan", which outlines the strategies that will be used to accommodate the increase in demand and also ensure the sustainable growth of the city.

2.1 Auckland in Context

The population growth around the region of Auckland and the distinctive low-density style of housing that is widely accepted by the residents as a cultural norm has resulted in a widely spread urban area. The Royal Society of New Zealand states that sprawl is a common factor in many cities, but Auckland's spread is particularly phenomenal. This is because the Auckland urban zone has less than a million residents but a geographical spread that is comparable to New York with 16.2 million residents, Los Angeles with 11.9 million people, and Tokyo with a population of 18.1 million residents.

During the period when urban sprawl was happening in Auckland, it created its own identity, which was the era when the most dominant mode of transportation was using motorway. Since 1915, most of the growth in Auckland, as the nature of the growth in Auckland, as the size of Auckland's size and because of the size of Auckland's size and the continual of the development of low-density housing areas created an urban form for Auckland. This growth pattern was also similar to the form that is found in Australia and America, as they developed during a similar period of widespread motor vehicle availability. In most of the cities in New Zealand, this urban form is employed, but maybe it isn't as visible as in Auckland because of the size of Auckland's size and main road network, which was known as the main instrument of Auckland's metropolitan expansion. Later, around the 1930's, the construction of state housing began, which followed the traditional style of New Zealand's single-level low-density villas and bungalows. These were considered to be more suitable for the families. In the period from 1950 to 1960, heavy investment was made in the private transportation infrastructure rather than in comprehensive public transportation. This was one of the fundamental influences on the rise of motorization. The Royal Society states that Auckland's spread is particularly phenomenal. This is because the Auckland urban zone has less than a million residents but a geographical spread that is comparable to New York with 16.2 million residents, Los Angeles with 11.9 million people, and Tokyo with a population of 18.1 million residents.


While the Auckland Regional Council supported the rapid growth, it introduced an increased dependence on personal vehicles. The Royal Society states that functional zoning also played an important part. This resulted in Auckland to becoming: Car dependent; Requiring high infrastructural capital and operating investments; and Requiring high levels of expenditure by families to operate across its spatial and architectural form. The Royal Society of New Zealand states that sprawl is a common factor in many cities, but Auckland's spread is particularly phenomenal. This is because the Auckland urban zone has less than a million residents but a geographical spread that is comparable to New York with 16.2 million residents, Los Angeles with 11.9 million people, and Tokyo with a population of 18.1 million residents.

The expansion of roads and motorways also intensification also occurred around the railway network and along the main road network, which was known as the main instrument of Auckland's metropolitan expansion. Later, around the 1930's, the construction of state housing began, which followed the traditional style of New Zealand's single-level low-density villas and bungalows. These were considered to be more suitable for the families. In the period from 1950 to 1960, heavy investment was made in the private transportation infrastructure rather than in comprehensive public transportation. This was one of the fundamental influences on the rise of motorization. The Royal Society states that Auckland's spread is particularly phenomenal. This is because the Auckland urban zone has less than a million residents but a geographical spread that is comparable to New York with 16.2 million residents, Los Angeles with 11.9 million people, and Tokyo with a population of 18.1 million residents.


High density. This leads to the conclusion that Auckland’s neighbourhoods are neither environmentally, socially or economically sustainable.

On the other hand, along with the growth in the city’s population growing, the size of the Auckland’s houses is also increasing. In 1991, the average size of a house in the Auckland region was 131 square metres, while by 2006 it had increased to 143 square metres. According to Statistics New Zealand, any new dwelling including apartments, had an average floor area of 190 square metres in 2006, but this had increased slightly to more than 200 square metres by 2010. When analyzing the trends in growing populations and how this has affected the size of dwellings, it states that the way the housing is managed currently throughout the Auckland region is unsustainable.

When analysing the other developing countries during this research, it can be said that when they went through the process of expansion, negative impacts are also introduced. This can clearly be seen on the “State of the Region”. Despite the report not addressing those issues of housing, most of the indicators point directly or indirectly to housing. Topics such as land use, coastal and freshwater quality, air quality, and waste production are all affected by housing construction. The report indicates a negative relationship between water quality, air quality and biodiversity in the urban environment, and with regards to solid waste, transport and energy demand.17
In 1999, a fifty years' report was produced by The Auckland Regional Growth Forum (ARGF), which was intended to plan the future growth of Auckland and to define the new role of New Zealand's largest city. Since there is a limit to greenfield changes, there is a need to accommodate the fast growth of Auckland and to define their growth plans and discovered a trend that the densities of developments and the distances people are required to travel, and ignoring the sustainability could be a misconception about the effect and cause of this movement. As the time goes on, personal movement is constrained by congestion, resulting in low density areas losing their attractiveness. However, the result shows that people who are forced to live in high density areas due to the lack of transportation and employment opportunities and also other infrastructure facilities within easy reach by foot or public transportation are gaining in attractiveness. Looking at those suburbs that have gone through the reconfiguring and diversification process over the years, it can be seen that it has benefited selected, dense, and growing people living in the community. Some of those benefits include:

- Protection of sensitive land resources;
- Reduced dependence on private transportation;
- Greater opportunity for social interaction and support;
- Greater housing choices;
- Increased social services and investment benefits; and
- Lower operating costs.28


For a city to have economic growth, fundamental features are required within the city. These include the need for a high enough density of the city to bring people and firms much closer together to share and exchange information, knowledge, and technologies, and launch new companies.29

During the period of growth throughout the 20th century, the majority of the suburbs around the railway and bus lines, such as Mount Eden and Kingslands were intensified using the Smart Growth principles. It was also proposed by the Auckland Council that not only the suburbs but also the central area at Greenland sites in Auckland.

When further analyzing the relationship between the density of developments and the distances people are required to travel, and ignoring the sustainability could be a misconception about the effect and cause of this movement. As the time goes on, personal movement is constrained by congestion, resulting in low density areas losing their attractiveness. However, the result shows that people who are forced to live in high density areas due to the lack of transportation and employment opportunities and also other infrastructure facilities within easy reach by foot or public transportation are gaining in attractiveness. Looking at those suburbs that have gone through the reconfiguring and diversification process over the years, it can be seen that it has benefited selected, dense, and growing people living in the community. Some of those benefits include:

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29 Auckland Regional Council, "Land Region" (Auckland Regional Growth Forum, 1999), 14.

2.4 Auckland’s Existing Resource Flow

Urban metabolism is a term which is used to study the performance of a design by analyzing the material and energy flow that arises from urban socioecological activities and global biogeochemical processes. Today most of the communities in Auckland operate in a linear flow of resources and waste. There are many such things, such as building materials, which are waste inclusive of CO₂ emissions and volatile greenhouse gases.

In addition, the water that is supplied from about 80% of Auckland’s drinking water and the Waitakeres, and they provide mainly located in two rangers, the Hunuas, underground springs. Auckland’s dams are spread throughout the Auckland region, as well as from the rivers and the Waikato. They are running by six different companies. It is said by Luke Appleby, “Where Does Our Power Come From?,“ Auckland Council, that the company that creates the materials.

The rivers come from the Waikato River, the Hunuas and the Hokianga River. The rivers provide about 8% of Auckland’s drinking water.

2.4.1 Where Do Our Resources Come From?

Water

Auckland imports all of the energy that is needed to keep it going. WaterCare supplies the water, which is sourced from three different locations. They are from 10 different dams along the Waikato River, the Hunuas and the Waitakeres, which is located in two rangers, the Hunuas, and the Waikanaes, and they provide about 80% of Auckland’s drinking water. In addition, the water that is supplied from Auckland City Water, Urban Metabolic, accessed July 21, 2016, http://www.urbanmetabolism.org.

Electricity and Fuel

New Zealand has 40 major electricity generation stations, which are connected to the electricity grid. They are running by six different companies. It is said by Luke Appleby, “Where Does Our Power Come From?,“ Auckland Council, that the company that creates the materials.

Apart from the generations stations, which are also supplied from out of the Auckland region due to the fact that there is no company that creates the materials.

Solid waste

Auckland’s current flow of resources. The ecological footprint represents the biologically productive land and sea area necessary to supply a city’s human population consumes, and to assimilates associated waste. By looking at this, we can calculate approximately how much of the Earth’s area we would need or if everyone followed a given style. Most of the communities and suburbs in Auckland relocate to the Waitakere Range and the Hokianga. Auckland has.

The ecological footprint can be defined as the following:

“The total area of productive land required to support its activities in a sustainable way. That land must produce an amount of resources equivalent to the sum of all the resources consumed by the community or suburb and is known as a Heterotrophic ecosystem. This means that the community or suburb relies primarily on external sources of energy.”

The ecological footprint can be calculated to determine Auckland’s footprint. Auckland’s current population is 1.3 million, which when multiplied by 5.6 hectares, it gives a total of 7.28 million hectares. When comparing the Auckland area, which is 10,600,600 acres.

2.4.2 Our Ecological Footprint

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3.1 Sustainable Urban Neighbourhoods

There are different principles for achieving sustainable urban neighbourhoods. According to David and Nicholas, sustainable refers to the ability of a neighbourhood and the wider urban systems to be sustained over time and to minimize their environmental impact. Urban refers to the physical location of an area and also to its physical identity and physical characteristics, whereas neighbourliness relates to the social and economic sustainability of the area. In other words, the term sustainable urban neighbourliness refers to a neighbourhood that consists of a strong connection between the physical environment, the social environment and the surroundings of the neighbourhood while decreasing the energy requirements and the environmental impact by employing a close urban metabolism.

3.1.1 What Is Urban Sustainability?

Much research has been carried out on the topic of urban sustainability, and a common theme found is that the main factor that helps to achieve an increase in sustainability, is to decrease those impacts which human activities have on the natural environment.

One of the critical issues we face in the current era is the question of what we mean by sustainability? In any research it is important to clarify what the term sustainability means as it has changed from the pioneer times. But the main feature is still important, which is that sustainability means self-sufficient. This has happened in a few of the small developments such as a small cluster of houses and even in individual building where the development is entirely self-sufficient, recycles its waste, produces its energy, and collects and treats its own water. The key to achieving this is to work with a closed metabolic cycle and also to optimize the relationship between the landscape and architecture.

There have been numerous attempts carried out in the past to computerize systems to design a self-sufficient village, mostly on a remote location. One of these examples New Zealand is the Alatari Eco-Village, which is situated in the far south-east of the country. This neighbourhood is planned to have a total of 67 sustainable buildings with high quality, energy-efficient features and communal areas such as farming land, and village square that holds the majority of the social buildings and community centres.

Most of the developments similar to this around the world or locally are very small in scale, rarely exceeding a population of 500, and they demand time and commitment from the community members and also the residents. This kind of design scheme has been considered by many to be an attractive way of living, however, it has been said by David and Nicholas that mostly environmentally sustainable developments are those people who would be able to live this way, and not everyone can afford these developments. The city is far more than just a collection of buildings, rather it can be seen as a series of interesting systems - systems for living, working and playing - crystallized into the building forms. They state that it is through these systems that we can achieve the future city which we dream. The majority of future urban systems that Robert and Brenda talk about aren’t easy to study or pin down to a single regionally and nationally. Due to this pins, the environment and neighbourhoods that face environmental disaster wouldn’t have any space in the future where sustainability is the key feature. Since thisDue to this, the population has a large footprint. For example, Auckland has a practical footprint that is 67 times bigger than the land Auckland has available. Some of the reasons for this are because of the building construction happens using hardwood from is gathered from rainforests, imported food from other parts of the nation or international markets, emit sulphur dioxide which harms the forests that are hundreds of kilometers away, as well as the waste products that are used as landfill or go to the sea and pollutes it. Robert and Brenda states that as the population grows there is also a chance that the neighbourhood would become unsustainable due to the rise in the resource depletion and pollution.

When analyzing the origins of the resources that Aucklanders require to meet the basic needs of people, most come from outside the Auckland region. Due to this, Auckland faces a problem of huge energy consumption and also pollution. In Auckland region. Due to this, Auckland faces a problem of huge energy consumption and also pollution. In Auckland, the waste from the Aucklanders requires to meet the basic needs of people, most come from outside the Auckland region. Due to this, Auckland faces a problem of huge energy consumption and also pollution. In Auckland, the waste from the Aucklanders is gathered from rainforests, imported food from other parts of the nation or international markets, emit sulphur dioxide which harms the forests that are hundreds of kilometers away, as well as the waste products that are used as landfill or go to the sea and pollutes it. Robert and Brenda states that as the population grows there is also a chance that the neighbourhood would become unsustainable due to the rise in the resource depletion and pollution.

From the knowledge around those, cities and neighbourhoods that face environmental disaster wouldn’t have any space in the future where sustainability is the key feature. Since this
According to UN-Habitat there are four key principles which can be used to help any development to achieve sustainability at the neighbourhood level or even city level. These are:

- Reduced inputs;
- Use local resources;
- Minimize waste; and
- Make use of the local economics.

Reduction of inputs
The first principle is to reduce the resources input and energy consumption of the community. This could be carried out by either creating the energy required locally or obtaining it from the district. The usage of greenhouse and also underground heating could be used to provide free heating in order to decrease the energy consumption.

Use local resources
The second principle is to make resources available locally for the community, such as the solar energy and the rain water from the roofs of the buildings. This also includes the treatment of the waste water and then reusing it.

Minimize waste
The third principle is that the neighbourhood should work towards minimizing the amount of unrecycled or unrecyclable waste exported from the area. It is said that a sustainable neighbourhood should at least be recycling the Continental levels by embedding recycling into the neighbourhood.

Make use of the local economics
The fourth principle of sustainability is the most crucial. It is based on the role that the urban area plays in the trading system. This means that the city or suburbs should be able to match with the demands of the residents, for example by providing job opportunities, providing multiple options for social gatherings, and so on. Thus the city centre or the suburb centre should be as a natural centre for trading. This plays an important role in promoting a closed urban metabolism.

Choguill also states that the economical component they are; economic, social, and also environmental sustainability. He states that an eco-city, an eco-neighbourhood consists of elements from the green urbanism. Those elements are the interaction between; energy and material, natural resources, local environment, economical sustainability and also social sustainability. Just like an eco-city, an eco-neighbourhood plays an important role in public and the community by promoting the need for a close urban metabolism by emphasizing the need for locally sourced food and also treating the wastewater locally.

Choguill states that there are four key features to achieving sustainability at a neighbourhood level; it should be able to match with the demands of the residents, for example by providing job opportunities, providing multiple options for social gatherings, and so on. Thus the city centre or the suburb centre should be an economic centre for trading. This plays an important role in promoting a closed urban metabolism.

3.1.3 Eco – Neighbourhood
The Eco-neighbourhood is a design ideology that is incorporated within the eco-city and helps it to achieve its goal. The eco-neighbourhood is an approach that focuses on smaller communities within the city limits, yet it is within the urban context. According to Hugh, an eco-neighbourhood consists of elements from the green urbanism. Those elements are the interaction between; energy and material, natural resources, local environment, economical sustainability and also social sustainability.

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Choguill also states that there are four key features to achieving sustainability at a neighbourhood level, it should consist of the following:

- Walkable to most of the facilities;
- Permeable and well connected with other streets;
- Good security for people walking on footpaths;
- Pedestrian-focused neighbourhood;
- Efficient public transportation; and
- Local Economic

According to David and Nicholas, the steps for achieving an eco-neighbourhood, it should consist of the following:

- The Eco-neighbourhood is a design ideology that is incorporated within the eco-city and helps it to achieve its goal. The eco-neighbourhood is an approach that focuses on smaller communities within the city limits, yet it is within the urban context. According to Hugh, an eco-neighbourhood consists of elements from the green urbanism. Those elements are the interaction between; energy and material, natural resources, local environment, economical sustainability and also social sustainability. Just like an eco-city, an eco-neighbourhood plays an important role in public and the community by promoting the need for a close urban metabolism by emphasizing the need for locally sourced food and also treating the wastewater locally.

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- The Eco-neighbourhood is a design ideology that is incorporated within the eco-city and helps it to achieve its goal. The eco-neighbourhood is an approach that focuses on smaller communities within the city limits, yet it is within the urban context. According to Hugh, an eco-neighbourhood consists of elements from the green urbanism. Those elements are the interaction between; energy and material, natural resources, local environment, economical sustainability and also social sustainability. Just like an eco-city, an eco-neighbourhood plays an important role in public and the community by promoting the need for a close urban metabolism by emphasizing the need for locally sourced food and also treating the wastewater locally.

Choguill states that there are four key features to achieving sustainability at a neighbourhood level; it should consist of the following:

- Walkable to most of the facilities;
- Permeable and well connected with other streets;
- Good security for people walking on footpaths;
- Pedestrian-focused neighbourhood;
- Efficient public transportation; and
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3.1.4 Eco-Cell

The concept of the eco-cell is derived from the theory of the biological cell of a living organism. In biology, a cell is the basic structural and functional unit of all known living things. A cell is known to be the smallest unit of life that can replicate independently. In addition, a cell is also considered to be the ‘building blocks of life’.14

This concept of the eco-cell was first introduced by Ken Yeang, a well-known Malaysian architect, ecologist and an author known for his signature ecoarchitecture and ecomasterplanning. In the early stages of the theory of eco-cell, Yeang defined this concept to be a means of integrating the inorganic form of the built components with the organic landscapes.15 This was carried out by creating a void which goes through at all the floors from the upmost to the basement, resulting in the creation of the ‘building block of sustainability’ which consist of all everyday needs.14

Yeang employed the theory of the eco-cell first in the master planning of the West Kowloon Waterfront, where he used the eco-cell as a device which allows to provide daylighting and natural ventilation to the inner parts of the building, bringing the vegetation from the roof down to all the floors by using a ramp which goes around the eco-cell. It also converts the sewerage waste into pure water by employing algae sewerage treatment water tanks. This idea was further developed for a master planning level when it was employed in the Tianjin Eco-City. This is where each eco-cell was designed to be like a living ‘cell’, meaning that the eco-cell has the ability to be replicated either independently or interdependent of the other eco-cell. The eco-cell was designed to be the ‘Building Block of Sustainability’ where each of this cell is a 400m by 400m block which has been considered to be within a comfortable walking distance. Some of the features that defines an eco-cell are:

- Good mix of land uses which are based on the Transit-Oriented Development principles.
- Local and centralized facilities are provided to serve the needs of the residents.
- The production of the energy required by the eco-cell locally;
- The emphasis on the green transportation; and
- The integration of the extensive green (vegetation) and blue (water) networks to provide an endearing living and working environment within the eco-cell.14

The idea of the eco-cell was used in the Tianjin Eco-City, leading to the principles being modified to be used on a master planning level. Hence the eco-cell was developed in a manner such that each of the cells would be able to be linked to create a bigger community. In this new idea, when four of the eco-cells are linked together they create an eco-community (as shown in Figure 14), and when four of the eco-districts are linked together they create an eco-district (as shown in Figure 14). When linking the eco-cells together, Yeang stated that it gives the cell the ability to introduce more green features, such as a larger green belt/corridor, better transit transportation connection, and also the ability to introduce district heating and cooling.

3.2 Eco-design Measurement Tool

There are many neighbourhoods and also buildings that are known to be sustainable. In order to determine if the sustainability features are effective or not, an assessment tool has to be used in order to make a fair comparison. For the purposes of this project, the existing assessment tool that has been developed by Beacon Pathway has been employed as it focuses on the analyzing majority of the Sustainable Neighbourhood principles that is the key focus when creating an eco-community.

The Beacon Pathway Neighbourhood Sustainability Observational Tool was influenced by the LEED neighbourhood tool and has been made specifically for the New Zealand context. The observational tool focuses on:

- the accessibility to the everyday needs;
- Access to the public transportation;
- Efficient use of the space and the local environment;
- Protection and the enhancement of the natural environment;
- Dwelling sustainability.

Footnotes:
14 Ken Yeang's competition entry for the masterplan of West Kowloon Waterfront.
15 Local and centralized facilities are provided to serve the needs of the residents;
16 The production of the energy required by the eco-cell locally;
17 Yeang's improvement on Eco-cell which he introduced by creating an eco-community or eco-district.
With the observation tool there is a need for a physical interaction with the site, as it requires walking around the area to collect the required data. For the international examples using this tool for comparison would be hard to make due to a lack of interaction with the site. However, the use of the Google Maps Street view was employed in order to give a rough comparison of the types of buildings in the development. In addition to this, the project developer/architect’s website was also used to determine the sustainable features that they employed.

According to Beacon Pathway, they state that the observation tool is an aid for assessment that can be used to rethink about the neighbourhood and to look at the way the built environment supports the sustainable behaviours. They declare that this tool is not a rating system that could be used as a rating system as in the tool, additional points are awarded to the neighbourhood if they contain any local art or any other features that help to give it identity.

The sole purpose of employing this tool is to provide comparison between the neighborhoods and also learn the sustainability features which each neighbourhood is employing.

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4.1 Hobsonville Point, Hobsonville, Auckland

Hobsonville Point in Figures

- Total site area: 167 hectares
- Built area: 31 hectares
- Commercial space: 8 hectares
- Residential space: 23 hectares
- Projected population: 8,000 people
- Proposed dph: 18 dph

Background of Hobsonville Point

Hobsonville Point was created by the Hobsonville Land Company to develop a strong, vibrant community that would set out new benchmarks for quality and affordable housing in Auckland. When fully completed, Hobsonville Point is expected to be a fully integrated urban community, consisting of environmentally sustainable features, schools, employment opportunities, future proof infrastructure, good connections with public transportation, and a mixed typology for a mixed community.

The construction of the infrastructures for Hobsonville Point started in 2009, and has opened up about 4km of harbour waterfront for the public to use it for recreational purposes and also community use. It has also developed a ferry connection and provided public transportation connection to the city.

4.0 Precedents Survey

Beacon Assessment Results

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Strengths of Hobsonville Point

Some of the strengths of the Hobsonville Point scheme which came up when using the Beacon Pathway Neighbourhood Sustainability Observational Tools are:

- Multiple facilities which provides everyday needs are just located within the walking distance;
- The use of boulevards and the incorporation of green infrastructure with the impervious surfaces creates a excellent protection for people walking along the street and also creates a habitat for wildlife;
- Most of the dwellings employs a high standard of energy efficiency for example the use of renewable sources of heating, the use of effective water management systems, and the ability of all of the rooms to be naturally ventilated;
- The public areas and also the footpaths have the ability of good passive surveillance and are easy to access while maintaining a casual interaction space;
- The street network also is laid out in such a way that it captures reasonable amount of solar access for most of the dwellings while maintaining a good connectivity.

Figure 17 The master plan of Hobsonville Point.

Figure 18 Mixed usage building which provides local retail opportunities.

Figure 19 Terrace Housing and also work-from-home houses.

Figure 20 Alternative mode of transportation available for the residents.

---


40% of the site is green space.
4.2 Earthsong, Ranui, Auckland

**Earthsong in Figures**

Total site area: 1.68 hectares
Built area: 0.67 hectares
Commercial space: 0.39 hectares
Residential space: 0.28 hectares
Projected population: 70 people
Proposed dph: 11 dph

**Background of Earthsong**

Earthsong Eco-neighbourhood is a small-scale co-housing project which was carried out by the members of the board and the cooperative group of residents to promote social relations. When the group was formed, it had a vision of creating a cohousing neighbourhood that would employ the principles of permaculture. The purpose of this proposal was a trial and to demonstrate a more sustainable urban neighbourhood model which could then be employed by other Auckland neighbourhoods.

The construction of the Earthsong was completed in 2008, and one of the important features is that it has been initiated, developed, funded and managed by ordinary individuals who wanted to make a difference, to live in a more cooperative and environmentally sustainable way and to share what they learn with others.¹²

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**Strengths of Earthsong**

Some of the strengths of the Earthsong scheme that were observed when using the Beacon Pathway Neighbourhood Sustainability Observational Tools are:

- Multiple neighbourhood facilities and also public transportation are just located within the walking distance;
- The development is centralized around a common house and the cars are isolated to a side of the site where they are stored; All the houses in the development have solar hot water systems with all the water from the roof being collected and stored in a water tank; The houses have been constructed using sustainable materials, for example, rammed earth, untreated macrocarpa and also timbers that have been re-used from the pre-existing buildings; The whole development also has allocated a space for commercial development, which will provide employment opportunities for the locals once it is completed.

**Figure 21** The master plan of Earthsong Eco-Neighbourhood

**Figure 22** The community building which is available for the residents to use.

**Figure 23** The street network which is employed within the development.

**Figure 24** The sustainable housing which the development employs using Rammed Earth.

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32 A Eco-Community Design

A Eco-Community Design 33
4.3 Stonefields, Mount Wellington, Auckland

Stonefields in Figures

Total site area: 110 hectares
Built area: 46.7 hectares
Commercial space: 22.9 hectares
Residential space: 23.8 hectares
Projected population: 8,500 people
Proposed dph: 20 dph

Background of Stonefields

The Stonefields development is a new central-eastern suburb; it was created to meet Auckland’s need for more housing. Previously, the location of the site was a quarry, hence it provided a challenge as it is lower than its surrounding.

Todd Property Group states that Stonefields is designed to provide the residents with a quality lifestyle since it forms a community. It also encourages interaction between the residents due to its huge open spaces and also the attractive streetscape it employs.

One of the special features of the Stonefields is its emphasis on the storm-water system. It employs the uses of the swales which have been specially been designed to integrate the wetland with the neighbouring Waiatarua reserve.

![Figure 25](image1.png)
Figure 25: The master plan of Stonefields development.

![Figure 26](image2.png)
Figure 26: The high density apartments available within the development.

![Figure 27](image3.png)
Figure 27: The green space available within the development.

![Figure 28](image4.png)
Figure 28: Terrace housing within the development to increase the density.

Table: Beacon Assessment Results

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Some of the strengths of the Stonefields scheme that were observed when using the Beacon Pathway Neighbourhood Sustainability Observational Tools are:

- The use of boulevards and the incorporation of green infrastructure with the impervious surfaces creates an excellent protection for people walking along the street and also creates a habitat for wildlife;
- The use of the storm-water system within the community to reduce rainwater runoff and allows for a thriving natural ecosystem;
- Most of the dwellings employ a high standard of energy efficiency; for example, the use of renewable sources of heating and the use of an effective water management system;
- The public areas and also the footpaths create good passive surveillance and are easy to access while maintaining a casual interaction space;
- The street network is laid out so that it gets reasonable amount of solar access for most of the dwellings while maintaining a good connectivity.

![Figure 30](image5.png)
Figure 30: The master use of Stonefields development.

![Figure 31](image6.png)
Figure 31: The high density apartments available within the development.

![Figure 32](image7.png)
Figure 32: The green space available within the development.

![Figure 33](image8.png)
Figure 33: Terrace housing within the development to increase the density.
Figure 29 The master plan of the development of the Vastra Hamnen.

Figure 30 The high density apartment blocks within the development Bo01.

Figure 31 The integration of the green infrastructure with the sidewalk.

Figure 32 Development Bo01 also consist of mixed used building to provide employment.

4.4 Bo01 Development, Vastra Hamnen, Sweden

**Bo01 Development in Figures**

Total site area: 22 hectares

Built area: 17.9 hectares

Commercial space: 7.6 hectares

Residential space: 10.3 hectares

Projected population: 10,000 people

Proposed dph: 40 dph

**Background of Bo01 Development**

The Bo01 development was initially designated as brownfield and contained a mix of landfill, shipping and car manufacturing waste. Due to the growth of the city, the Bo01 Development site became a part of a brownfield redevelopment in Vastra Hamnen. It is a high-density mixed-used development, which integrated aesthetics, spaces for social interaction on various scales and also exhibits the sustainable planning and high tech building technologies.

The Bo01 development focuses on five major objectives. These are soil reclamation, 100% locally produced renewable energy, better public transportation network, ecological buildings, and providing biodiversity for natural life. 57

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**Strengths of Bo01 Development**

Some of the strengths of the Bo01 Development that were observed when using the Beacon Pathway Neighbourhood Sustainability Observational Tools are:

- It provides most of the energy used heating, cooling and lighting. It also employs the concept of the usage of low energy.
- The different styles of architecture employed in the location lead to the creation of an interesting, diverse city which invites people to walk and spend time in the area;
- It uses an open rain water management system, allowing the area to improve its biodiversity;
- Most of the rainwater collected from the site and the grey water is treated within the Vastra Hamnen district;
- The area has a biogas plant which allows the development to convert its organic waste to biogas. This is later used for heating house and powering cars.

**Summary**

The Bo01 Development is an innovative, sustainable project that demonstrates the potential of high-density mixed-use development to provide a variety of benefits, including improved community livability, increased economic opportunities, and enhanced environmental sustainability.
4.5 Hammarby Sjostad, Sweden

Hammarby Sjostad in Figures
Total site area: 200 hectares
Built area: 60 hectares
Commercial space: 20 hectares
Residential space: 21.5 hectares
Projected population: 20,000 people
Proposed dph: 60 dph

Background of Hammarby Sjostad
Hammarby Sjostad is another site in Sweden that redeveloped a brownfield site to create a sustainable community. Initially, the site was a heavily industrial area, but due to the high demand for housing, it was seen as a good site to do redevelopment as it was next to a harbour.

Hammarby Sjostad is a well-planned community, which employs a close urban metabolism. The inhabitants carry out their own recycling, treat the sewage locally, produce district power, and convert the organic waste to biogas. The main driving factor of this development was a good public network connection, local creation of the energy, a decrease in water consumption, reduction in landfill waste, and the creation of a place for residents to interact, socialized and work.1

Strengths of Hammarby Sjostad
Some of the strengths of the Hammarby Sjostad that were observed when using the Beacon Pathway Neighbourhood Sustainability Observational Tools are:

- The design was carried out to ensure high quality of public spaces and good environmental performance from the buildings;
- The development employs a close urban metabolism, which allows the development to improve the environment, biodiversity;
- Most of the rainwater is collected in water tanks, which decreases the site's storm water runoff;
- The heating, transportation and waste collection systems were integrated in tandem to decrease the amount of energy used;
- The area also has a biogas plant which allows the development to convert its organic waste to biogas, later used for heating houses and powering cars.

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Figure 19: The master plan of Hammarby Sjostad development
Figure 20: The use of high-technology solar panels on the apartment block
Figure 21: The integration of the blue infrastructure with green infrastructure
Figure 22: The use of green modes of transportation within the city
4.6 Summary of Precedents

From the study of the precedents above, it can be seen that several successful sustainable principles were employed to make a community sustainable. These include features that could be used in the eco-cells.

The main principle that arises is the use of a central green space. This is strongly displayed in the Earthsong Eco-neighbourhood, where the whole development is oriented towards the central green field. This consists of a major circulation route, the storm water retention pond, open space for farming and acts as a socializing area. This principle can also be seen in the Hammarby Sjostad. Since this proposal consists of a high-rise development, each of the buildings has been provided with a courtyard, this acts as a social space in both residential and commercial buildings. According to Farr, when an open space is located within a three minute walk from any residents, it has two major advantages. First of all, it increases the value of the price of the house and secondly, parks and open spaces help to contribute to a more liveable community.

Alongside the use of a central green space, a second principle that has been employed is the use of a circular urban metabolism, which has been successfully displayed in most of the international precedents. This is the most important feature towards helping a neighbourhood to become sustainable.

Finally, the third principle employed in the international precedents is that the streets are given different hierarchies. This is important because this helps to create a green infrastructure network which helps to improve the biodiversity. The New York City Department of Transportation states that improving the access of people to the site either by bike or by improving transit connectively can help local retail. Additionally, including the vegetation into the streets helps to create a more inviting and pedestrian-scale environment that encourages the people to stay and stroll.

Some of the other precedents I studied are:
- Tianji Eco-City;
- Self-Sufficient Town at Henna, Finland;
- Regen Village; and
- Living Machine by John Todd.


5.1 Brief
As stated previously the main intention of an eco-cell is to help Auckland during its expansion to accommodate an increase in population, and also to help Auckland achieve to reach its vision of "the world’s most liveable city." This could be carried out by improving the theory behind the eco-cell, which was originally designed by Ken Yeang, to incorporate a framework suitable for use in the Auckland region. In order to understand the concept of the eco-cell, the four different categories that makes up an eco-cell needs to be explicated.

Those four categories are:
1. Accessibility to a central green space;
2. Diversity of building opportunity and choice;
3. Self-sufficiency in key energy resources; and
4. Access to a variety of public transportation choices.

Accessibility to a Central Green Space: This idea of the central space comes from a study of the precedent’s study. The reason behind having a central courtyard is to demonstrate of principle on how the green spaces could be used to improve the quality of life of the neighbourhood of the eco-cell; to improve the green infrastructural network within the eco-cell; to preserve the ecology and biodiversity; and also to improve the micro-climates of the site. In addition to the benefits that a central green space gives, the central green space within the eco-cell would consist of a green machine that would allow the eco-cell to produce sustainable energy and also to provide the community with a space where children could play and have fun safely.

Diversity of building opportunity and choice: The eco-cell would create a community that would meet one’s daily needs and also one’s needs over a lifetime. This community is a place where most of the needs can be met within walking distance. In order to achieve these short-term and long-term needs in an eco-cell, it needs to include different varieties of land uses, building types, and dwelling types. The different varieties of building types and dwelling types will serve the different needs an individual has over their lifetime. For example, when a young couple moves out of the family home, they often start of by renting a small, low cost apartment. As their economic status improves, they move up by renting a better apartment or even buying a home for themselves. Having a variety of land uses and building type allows the occupants to achieve a high quality of life without needing a car to achieve it and at the same time creates a universal independence at the opposite ends of the age spectrum.

Self-sufficiency in key energy resources: With the increase in density within an eco-cell compared to that in typical Auckland suburbs, the eco-cell would be able to integrate sustainable design into the density. This is because the medium to high density and different typology of the buildings allows the eco-cell to employ and also support different modes of producing renewable sources of energy, such as solar energy, wind and bio-digesters, thus helping to reduce the carbon generation, the ecological footprint and the energy consumption of the eco-cell.

Access to variety of public transportation choices: An eco-cell would also provide the people with a wide range of transportation types, meaning they could choose to walk, cycle, and even use a transit vehicle around the neighbourhood. An eco-cell also includes a good connection to a transit service to adjacent eco-cells and also regional destinations. Within the eco-cell, the streets consist of sidewalks on both sides of the street, with the majority of the street network designed for a maximum automobile speed of 50 kilometers per hour. The street network also becomes the transit corridors within an eco-cell that allows to supports most of the utility infrastructure while providing wildlife corridors linking habitats within and across the region.

Figure 41: The Image Showing the Four Major Categories which an Eco-Cell is made of and also the features and the benefits which those Categories

5.0 Design Process

Auckland Council, “Auckland Now and Into The Future.”
One of the important aspect of the master plan is the grey infrastructure as they address safety and also the mobility. In an eco-cell, the types of streets that are employed are different compared to the current designs of the roads that are being used in the Auckland region. The different types of streets being employed promotes walkability, cycling and helps to link the different green infrastructure to create a network.

There is a total of three different types of streets which would be used within the eco-cell. They are:

- Shared Streets;
- Neighbourhood Streets; and
- Residential Boulevard.

**Shared Streets**

The first type of the street is the shared street. This is where the barriers between cars, pedestrian and cycling are removed and they share the road respective to each other. This has already been started to be employed within the CBD of Auckland City and it has been showing wonderful benefits. Some of the benefits of this type of the streets are that the cars speed decrease by 25%; it helps to improve the quality of life as the amount of foot traffic increases adding to make a liveable street; the noise and pollution decreases; and it helps to boost up the retail and property value.

The proposed shared street design as shown in Figure 42, is slightly different from the typical design. The difference on the proposed design is the addition of green vegetation along the both side of the road which would help to create the green infrastructure network and also provide opportunity to use the space for community farming or gardening.

This type of street you be used in the proposed eco-cell design as a street which would link the house, apartment to the neighbourhood streets.

**Neighbourhood Streets**

The second type of the street is the neighbourhood street. This is the type of street that has been used as the major roads in Auckland region. This type of road consists of footpath, cycle lane, and road for cars. With the current design, it consists of some faults which has been noticed by the author as a road user. Some of the faults are that the pedestrians don’t feel safe while walking next to cars passing by at a high speed.

Due to this reason, the proposed Neighbourhood type of street, separates the pedestrians from the road by introducing a region of green space between the footpath and the road as shown in Figure 43. Some of the benefits of this type of streets are that it creates a safer walking environment for the pedestrians; it creates a pleasant walking environment; creates shading during sunny weather; and also it helps to improve the value of the residential, retail and the commercial space.

This type of street would be used as a “ring” road which would be used to link the traffic coming from the shared street to the Residential Boulevard.

**Residential Boulevard**

The third type of the street is the residential boulevards. This type of street has been started to be used in the new communities which has been developed from which one of the example is the Hobsonville Point Road. From the experience of using this type of street as a pedestrian, some of the positive impact that this street provides are the feeling of being safe. This is achieved by the usage of the trees which works as a wall and separates the pedestrians from the cars. Another advantage of this type of road is that it improves the green infrastructure network of the community as it is used to link the green parks and spaces together.

In the eco-cell, the residential boulevard has been used as the major road which connects each eco-cell and also the road which gets connected to the “ring” road.
5.3 Programmes of an Eco-Cell

For this project, the eco-cell explores most of the functions that are required to fulfill the daily needs of an individual. This would help to reduce the need for travel to meet the daily needs. The programmes would specifically consist of:

- Multiple range of housing types such as standalone house, terrace housing, work-from-home housing, and apartments;
- Commercial building;
- Retail facilities;
- Community facilities;
- Medical facilities;
- Exercise and gym facilities;
- Public transport building;
- Biomass plant;
- Community farming area and community parks;
- Living machine.

Figure 45: The program of the Eco-Cell.
5.4 Initial Planning of Eco-Cell

Figure 48 Image above - Step 1 - A central Green Park/Space is where the most of the circulation and also the community farming would be carried out.

Figure 49 Image above - Step 2 - The central Green Space is connected to the main road using a residential boulevard type of street. This creates four major blocks.

Figure 50 Image above - Step 3 - A secondary ring road is then created using the Neighbourhood Street to break down the massive block and also to create a perimeter Green Infrastructure Network which would be integrated with the building design.

Figure 51 Image above - Step 4 - The block is further broken down into smaller blocks, which allows the eco-cell to incorporate passive features and also adds to create a street network allowing the residents to choose a shorter walking route to the nearby facilities.

Figure 52 Image above - Step 5 - After the street network has been laid out, the central park is then connected with Green corridors, that leads out in all four direction to the outer part of the eco-cell.

Figure 53 Image above - Step 6 - The next step is to give the mass blocks some building programmes. This is given using the principles from the precedents. These are that the central buildings around green space and the four major roads are highly densed.

Figure 54 Image above - Step 7 - The final step is to give the building height and create a variety of different typologies for the houses, retail, and commercial spaces available.
5.5 Plan and Analysis of Eco-Cell

5.6 Summary of Eco-Cell Framework

From the above exploration on the factors which helps to create the framework are:
- the central courtyard/ green space which consist of the living machine;
- the green infrastructure corridor which goes from the central courtyard to the outer side of the eco-cell;
- the high density dwelling on the central of the eco-cell and decreasing as the edge of the eco-cell approaches;
- connection of the residential blocks to a community farming area; and
- the ring road within the eco-cell which helps to create a street network and also allows to link green spaces together.
6.1 Site

With the selection of a test site, a functional approach and the typical features to the site with other suburbs is needed. Some of the aspects which is needed to be considered to be known as a typical aspect of Auckland suburbs are:

- high dependency on private vehicle;
- poor connection to public transportation;
- high traffic;
- lack of space for social activities;
- less job opportunities within the suburbs; and
- poor green infrastructure connection.

6.2 Site Description

The site was chosen using the above guideline which indicates the problems which are typical to the site in any Auckland suburbs. The site selected to check the feasibility of the eco-cell is located at the suburb of Mount Roskill which is controlled by the Puketapapa Local Board. The site consist of more of the residential end of the Mount Roskill which starts from John Davis Road and to the junction of Ellis Ave and then to the the White Swan Road and heading towards Richardson Road heading towards the Southern Western Motorway. This area is shown on Figure 54 which is highlighted in red.

Some of the figures of the test site are:

- Total site area: 30.5 hectares
- Number of dwellings: 393 dwelling
- Current density: 12 dph
- Current population: 820 people
- Current green space area: 2.5 hectares
- Current imperious surface area: 5.8 hectares

Figure 54 Location of the test site in Auckland Region which is highlighted in red.
The major streetscape employed within the study area.

The majority of the houses being highly dependent on the private vehicle.

The current building stock are mostly 1-2 storey detached dwellings.

The secondaries streetscape which is found for just few meters.

The retail building stock which is located within the site.

The current green infrastructure within the site which is hardly used due to security problems.

Figure 55 Images of the red and green infrastructures, building typology and unusable park as it is today.

6.2.1 Site Analysis Area

One of the crucial element on a master planning is to determine on what happens to the neighbourhood when a development is carried out. Due to this reason the image on the left shows the test area, highlighted in red, and also the neighbouring building on the opposite side of the street, which is highlighted in yellow.

The major reason for this addition on the analysis is because after the development the streetscape changes and also we as designers also need to consider how the design would look and also merge with the surrounding.

When looking at the test site in figures it measures about 530m on the Richardson Road, 620m on the John Davis Road, 607m on the Ellis Ave, and 590m on the White Swam Road.

The major streetscape employed within the test area.
6.2.2 Draft and Proposed Unitary Plan

The March 2013 draft Unitary Plan for the test area suggest that the usage would be changed from “Single dwelling traditional site” to “Mixed Housing Suburban” as shown in figure 57.

This is where the density is to be maintain in a moderate level and major intensification wouldn’t be carried out. In this area, the developments are mostly allowed two storey detached and attached dwellings.

The proposed Unitary Plan for the test area suggest that the usage would be changed from “Single dwelling traditional site” to “Mixed Housing Suburban” as shown in figure 58.

This is where the density is to be maintain in a moderate level and major intensification wouldn’t be carried out. In this area, the developments are mostly allowed two storey detached and attached dwellings.

However, I believe that the neighbourhood should be converted to mixed usage so more retail and commercial space could be introduced. This would help in removing the dependency of the people from the cars.
6.2.3 Current Hierarchy of Streets

One of the way to understand the street grid currently being employed are by understanding the hierarchy of each street. The streets within the test site could be broken down into five different category. They are:

- high street;
- secondary street;
- residential street;
- cal-de-sac; and
- pedestrian street.

The image on the right shows the street network which are being employed currently. According to the knowledge around, breaking the streets into hierarchy loses the ability of the neighbourhood to be walkable as it loses the connectedness; and also it doesn’t give the pedestrians the different options to navigate through the site.

6.2.4 Current Building Conditions

In order to understand how sustainable the current dwelling are, a critical analysis was carried out on all the dwellings with the test area and ranked them on which category they fall to. Those categories are:

- good or newly built;
- averagely maintained; and
- poorly maintained.
6.2.5 Building to Site Ratio

One of the factors which determines the sustainability of a dwelling is also the amount of site coverage it has. It is said that if a building has high site coverage and less density then it is considered to be wasting a lot of space which could be used for cropland.

With the test site there are majority of the buildings which use up to 26 - 50% of the site or higher, as shown in figure 61, is said to be wasting land space which would be used efficiently.

6.2.6 Current Green Infrastructure

Green infrastructure are one of the major component which leads to sustainability. However, this needs to be linked together as a network. Currently the green infrastructure within the test site are all isolated with each other. This leads to the limitation on the biodiversity of the site and also it can't be used to provide a encouraging outdoor physical activity area.
6.3 Current Consumption Data

In order to determine the current consumption data for test area, the overall figures from the Puketapapa Local Board has been used due to the unavailability of the data for just the specific area. The population of the Puketapapa region is approximately 50,781. The test area consists of 820 people, which is 1.61% of the Puketapapa region.

**Puketapapa Region in Figures**
- Total area of Puketapapa Region: 9,500 hectares
- Population of Puketapapa Region: 50,781
- Total area of test site: 30.5 hectares
- Number of dwellings: 393 dwelling
- Current population: 820 people (average per household: 2.1)
- Percentage of population in relation to Puketapapa population: 1.61%

### Inputs

| Water (Renewable, locally sourced) | 485L per dwelling per day is the average for Puketapapa region | 173,630L per day (485 x 358) |
| Energy Consumption (Non-renewable, sourced from outside the Puketapapa boundaries - Residential region) | Electricity (4,583,188 kWh/yr is the total consumption of Puketapapa region) | 67,831 kWh/yr (4,583,188 x 1.48%) |
| Gas (2,156,216 kWh/yr is the total consumption of Puketapapa region) | 30,912 kWh/yr (2,156,216 x 1.48%) |
| Fuel (Residential Energy Consumption) | Petrol (Non-renewable, sourced from beyond the cities boundaries) (61,439L per year is the consumption of Puketapapa region) | 909.3L per year (61,439 x 1.48%) |
| Diesel (Non-renewable, sourced from beyond the cities boundaries) (15,385L per year is the consumption of Puketapapa region) | 227.7L per year (15,385 x 1.48%) |

### Output

| Waste (kerbside) (The average for Puketapapa region is 128kg per person per year) | Transfer Station (57.95%) | Landfill (42.05%) |
| 96.77 tonnes/yr | 56.08 tonnes/yr | 40.69 tonnes/yr |

| Green House Gases (Estimated at 1,337.84 tonnes of Carbon Dioxide equivalent per year for Puketapapa region) | 19.8 tonnes (1,337.84 x 1.48%) |

| 66.77 tonnes/yr | 30.00 tonnes/yr | 49.69 tonnes/yr |
7.0 Design Outcome

7.1 Master Plan Concept 1

From the above analysis on the test area the special features, characteristics and also the currently hierarchy of the streets was preserved during the process of densifying Mount Roskill using the ideology of eco-cell.

The initial approach of the application of the idea of eco-cell was directly placed on the test site to determine the effectiveness of the eco-cell without changing any of the framework.

Due to the size of the test site being irregular rectangular size, this exploration consisted of two full eco-cell and with two half eco-cell as shown in figure 66.

This exploration of the direct application of the eco-cell idea revealed multiple strengths of the idea and also multiple weakness.

Some of the weaknesses of this explorations were:
- the roads. The straight roads instead of being a feature which provides safety could become dangerous for the pedestrians as drivers turn to speed up in such road conditions;
- the location of the retails. Due to the amount of retails which this proposal looks at there could be a chance that they might not be able to be sustainable to run as the density of each eco-cell isn’t sufficient enough to support multiple retails;
- that none of the current infrastructures would be able to be used or maintained; and
- that with this proposal some of the residents started to form their own community instead of being part of the eco-cell (as shown in Figure 64)

Some of the strengths of this explorations were:
- that the location where the all eco-cell meets, it creates a large green space (public parks which the public could use for multiple activities and also social gathering space (as shown in Figure 65); and
- that most of the highly densified dwelling consisted of communal farming area.
7.2 Master Plan Concept 2

From the above exploration, the division of the site to 2 full eco-cell and 2 half eco-cell wasn’t maintaining the principles of the eco-cell. This is because when the eco-cell is divided into halves, the idea of central green space/park is lost. Hence for this exploration, the main difference is the division of the eco-cell and also reusing the majority of the grey infrastructure while maintaining the current green infrastructure.

The size of the eco-cell in the framework is 400m by 400m but for this exploration the site and grey infrastructure has been used to determine the size of each eco-cell. This was carried out while keeping in mind the principles of the eco-cell. This was carried out by firstly, expanding the Cal-de-sacs to a residential street. This helps to improve the connectivity and also provides options for the pedestrians for walking. Due to the steep typology the eco-cell 1 which is located on the corner of Richardson Road and White Swan Road, this eco-cell becomes a special example where it wouldn’t be able to become fully sustainable and complete. Hence this eco-cell becomes a retail, commercial and public transportation hub.

From this exploration of conserving the majority of the grey infrastructure within the eco-cell idea revealed multiple strengths of the idea and also multiple weakness.

Some of the weaknesses of these explorations were:
- the idea of the street connection to the centre of the ring road has been lost leading to plenty four way intersection;
- the idea of clear central green space/park has been broken down by the grey infrastructure hence the idea of having living machine gets affected; and
- the perimeter road of the eco-cell creates a straight road which could become dangerous for the pedestrians as drivers turn to speed up in such road conditions.

Some of the strengths of this explorations were:
- the idea of having multiple small parks spread around the eco-cell that is connected with the green streets instead of the long green corridor running from the central green space/park helps to provide more social space which is secure;
- the retails being located on the edge of the eco-cells in order to serve the four eco-cells to sustain itself;
- the idea of the street connection to the centre of the ring road has been retained leading to plenty four way intersection.

Due to the steep typology the eco-cell 1 which is located on the corner of Richardson Road and White Swan Road, this eco-cell becomes a special example where it wouldn’t be able to become fully sustainable and complete. Hence this eco-cell becomes a retail, commercial and public transportation hub.

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- the retails being located on the edge of the eco-cells in order to serve the four eco-cells to sustain itself;
7.3 Master Plan Concept 3

Development from previous concept:

- The division of the eco-cell has been slightly changed in order to breakdown the road and maintain the framework.
- The ring road has been used to form the central green space which also accommodates the apartment blocks surrounding it.
- All the retail has been moved to the edge of each eco-cell, so that the retails could sustain itself due to high population it serves.
- The bio-digester has been incorporated with the living machine.

Some of the strengths of this explorations were:

- All the houses, apartments, and commercial spaces have easy access to the public space which helps to increase liveability.
- This concept maintains some of the existing houses in the eco-cell 1.
- That the roads had better connectivity which would allow the pedestrians to have plenty route options.

Figure 7.3 Image on the right, shows the masterplan of the test site.
Figure 74 Image above, highlights the three different types of street used:
Orange Dots - Residential Boulevard
Blue Dots - Neighbourhood Streets
Red Dots - Shared Streets.

Figure 75 Image above, highlights the major green space (light green dots) which the public could use and also the linkage of the parks to each other (dark green dots).

Figure 76 Image above, highlights the living machine which is located in the centre of the central green space.

Figure 77 Image on the right, indicates the division of the eco-cell while maintaining majority of the grey infrastructure and with respect to the current green infrastructure.
Figure 78. Image on the right: massing plan of the test area, which would be designed in detail.
7.4 Building Design Exploration

7.4.1 Formal Consideration

In order to achieve the vision of the Auckland City to become “the world’s most liveable city”, just the sustainable neighbourhood master planning isn’t enough. The buildings which are built within the neighbourhood should also be sustainable, low carbon usage, and also incorporate the other passive features which are currently in the market.

For the selected apartment buildings within the section from the eco-cell that is going to be designed in detail (as shown in figure 78) has to occupy the following features:

- Good connectivity to the central public space;
- Provide a space for communal farming;
- Provide various types of apartment to cater for residents of all ages and from every stratum of society;
- Collect rainwater and use for human consumption;
- Use different methods to generate energy;
- Create environment which helps to improve livability of the neighbourhood;
- Also is connected to the living machine in order to reduce the sewage from the neighbourhood.

7.4.2 Linkage to Central Green Space

One of the main feature of this site is the easy access to the central green space. It has been said by Parallelus that an easy access to a green space has multiple benefits for the residents. Some of those benefits are:

- Good health;
- Increases stress levels;
- Allows residents to be part of more physical activities and better mental health.

For the development of the apartment block with the access to the green space, the atmosphere aimed to be achieved is as shown in figure 79 which has been inspired from the Mandawork’s first-prize Vaasan Raviradan master plan entry in Vaasa, Finland.

7.4.3 Communal Farming

The concept of the communal farming in an urban context isn’t a new phenomenon, this idea has been going around most cities who are heading to eco-city. The main reason behind this shift is because:

- It decreases the need to transport the food from outer region of the city;
- It helps to attract the farmers into the city to improve their livestyle and also allows the local to be involved into farming;
- It also helps to decrease the ecological footprint of the city;
- It acts as a drainage surface for the water which comes from the urban fabric;
- It is a element required for circular urban metabolism.

For the development of the green space, the idea of providing farming space within the building and also the green courtyard would be used. This idea has been inspired from a private garden (as shown in figure 80) which was created by Arterra Landscape Architects and also from the ideas of verticle forests (as shown in figure 81) which was designed for Asian retirement communities in Singapore.
7.4.4 Living Machine

Living Machines are ecologically-based wastewater treatment facilities which are usually built within a green house. With the usage of living machine, it gives the community the opportunity to use its own waste to create local green space, produce clean water that could be reused within the community. This idea of using plants create a living machine was first by John Todd as shown in figure 83.

Figure 82 Image below, shows the four stages of living machine.

Figure 83 Image on the right, is the living machine which was design by John Todd.

7.4.5 Variety of Apartment Type

Figure 84 Image above, plan and axonomatric view of a 1 bedroom apartment with a balcony space which would be used for farming.

Figure 85 Image above, plan and axonomatric view of a 2 bedroom apartment with a balcony space which would be used for farming.

Figure 86 Image above, plan and axonomatric view of a 3 bedroom apartment with a balcony space which would be used for farming.
7.4.6 Internal Planning

Figure 87: Image Showing the floor plate of the Apartment Building.
Figure 88: Section through the Apartment Building and showing the site.

Communal Farming Area
2 Bedroom Apartments
1 Bedroom Apartments
2 Bedroom Apartments
7.5 Developed Design

7.5.1 Energy Efficiency

With the circular urban metabolism, one of the requirements of the concept is to produce its own energy to decrease the dependence on the main grid. Hence the apartment block also incorporates the usage of energy efficient designs. Some of those features are:

- The usage of louvers and overhangs to avoid the high angle sunlight coming into the apartment space and also do reflect those light deeper into the apartment;
- The use of double skin facade on the north and east sides to naturally ventilate the apartment during summer;
- The use of air within the double skin facade as a barrier during winter to avoid heat loss from the apartment;
- The use of vegetation on the ground floor where the vents for the double skin facades is. This allows to clean and cool the air which enters the space between the double skin;
- The use of concrete floor on the most habitat rooms of the apartment such as bedrooms, lounge and kitchen.
7.5.2 Water Collection

Water is the crucial element of a neighbourhood, and in Auckland region majority of it comes from outside the Auckland region. This leads to high investment on the infrastructure which are required to transport the water to the neighbourhood.

In a circular urban metabolism, water is an element which is stated to be collected and stored within the site. Hence the apartment building has the ability to collect the rainwater from the roof and then store it in the water tanks which could be later used for the watering the crops, cleaning cars, flushing the toilet, and for human consumption.

For the design, the water from the apartment roof and the impervious surfaces is carried to the water storage tank which is located on the basement of the apartment block.

7.6 Eco-Cell Implication Timeline

The implication of the eco-cell principle is a 50 years process. This breakthrough can be seen timeline which is the figure 95.

During the first five years, there would be couple of the houses which would be replaced with the terrace housing and even the apartment blocks. During this time, the spaces allocated for the parks and green space would also be started. There would also be a better connection of the public transport which would allow people to start to be dependent on the public transport infrastructure.

During the period of five to ten years, the two wind turbines would be installed and the living machines would be near completion. During this time more retail owners and also commercial owners would head towards work-from-home concept and the programmes of the eco-cell would increase.

By the twentieth year of the development, all the four wind turbines would be completed and the people would also start to depend on the public or green modes of transportation.

By the thirtieth to fiveieth years, the eco-cell would be fully independent and would be producing its own energy, treating its waste, and provide better lifestyle for the people.
7.7 Data Comparison

To ensure that the implication of the eco-cell frame works, one of the manner to check its feasibility is by analyzing the existing site data with the new data which would come from the proposed implication.

The following six data would be used to compare the existing conditions with the new proposal:

- Density;
- Public Space;
- Water Consumption;
- Energy Consumption;
- Waste output;
- Food

Existing Data

1. Density - 12dph
2. Public Space - 2.5 hectares
3. Water Consumption - 173,630L/day (Sourced from Outside the area)
4. Energy Consumption - 67,831kwh/yr (Sourced from Outside the area)
5. Waste output - 96.77 tonnes (Treated Outside the Region)
6. Food Grown - n/a

Proposed Data

1. Density - 25dph
2. Public Space - 7.3 hectares
3. Water Consumption - 180,000L/day (Sourced Locally)
4. Energy Consumption - 67,831kwh/yr (Sourced Locally)
5. Waste output - 4.00 tonnes (Treated Outside the Region)
6. Food Grown - 90%

Despite the proposed data on the water consumption, energy consumption, waste output and food is an estimate, there are high chances that those figures could be less since the eco-cell can generate power using wind turbines, and the living machine; the water being collected from the roof and impervious surfaces; and also has the space for growing own food.
8.1 Concluding Remarks

The aim of this project was divided into two sections. Firstly, the primary aim of this project was to design the framework of an eco-cell which could be employed in any typical Auckland suburbs. Secondly, the feasibility of the framework of the eco-cell was tested on the test site located in Mount Roskill.

The first objective of this research was to analyse the developed culture of Auckland and how it became a reality. This was followed by the analysis of the need of a high density area and how they help to achieve sustainability.

The research which was carried out by literature and also by analysing the precedents determined that the cities are turning to walk towards sustainability. This review also helped to determine that the use of eco-cell originally designed by Ken Yeang would be the best solution and device for Auckland Region that could help to achieve Auckland’s Future vision.

Hence the framework of the eco-cell was redesigned using the two major principles. They are the principles of walkable neighbourhood and the principle of green urbanism.

Upon the explorations on the redesigning of eco-cell idea to suit the Auckland culture, I believe the eco-cell consists of majority of the sustainable features which are currently in the market.

When this was applied to the test site, the framework was able to achieve its aims. Those were:

- to create a integrated and vibrant community;
- create a diversity of jobs, recreational activities, and residential types; and
- to lead to carbon neutrality.

In addition to those aims stated above, the interconnection of the passive features with the building has been shown in the concept of apartment block that is linked to the living machine. This demonstrated on how those features would work together to make the eco-cell sustainable.

8.2 Further Development

We all know that as the time progress, and more technologies and interventions are carried out, the framework of the eco-cell could be made more sustainable and even lead to be off the grid and create its own energy, manage with its waste, and even promote better lifestyle opportunities.

This is one place where the framework of the eco-cell could be improved over the time. In addition to this, I believe that more sustainable features could be implied within the apartment block as they are been introduced.

With the help of the Auckland Transport, if the location of the Public Transportation Routes could be changed so that it would cross the center of the eco-cell, this could help to support the retail located within the eco-cell and also help to promote green modes of transportation.


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11.0 Final Presentation

An Eco-Community Design for Mount Roskill.

An architectural project based on transforming Mount Roskill to become more affordable, liveable, resilient and sustainable.
Declaration

Name of candidate: Zeelesh Dakshe Kurmar

This Thesis/Dissertation/Research Project entitled: An Eco-Community Design for Mount Roskill

is submitted in partial fulfillment for the requirements for the Unitec degree of
Masters of Architecture (Professional)

Principal Supervisor: Dragko Bogumilovich

Associate Supervisor/s: Casar Wagner

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